RESEARCH PAPER

Effect of Neural Mobilization on Carpal Tunnel Syndrome in Post Mastectomy Lymphedema Patients

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ABSTRACT

Background: Carpal tunnel syndrome among patients with post-mastectomy lymphedema has attracted considerable global attention. There is potential evidence supporting neural mobilization as an alternative therapy due to its therapeutic benefits in addressing musculoskeletal weakness and associated functional deficiencies.

Objective: To evaluate the therapeutic effect of neural mobilization in treating symptoms of carpal tunnel syndrome in post mastectomy lymphedema patients.

Patients and Methods: Forty female participants diagnosed with carpal tunnel syndrome secondary to post-mastectomy Grade III lymphedema (symptoms persisting for at least three months) were recruited from Shebin El Kom Educational Hospital. Participants were aged between 40 and 60 years and were free from any post-surgical complications. They were randomly allocated into two equal groups; Group A: twenty participants received neural mobilization, plus routine physical therapy, two sessions per week for twelve weeks, as well their standard medical treatments; and Group B: twenty participants received routine physical therapy, two sessions per week for twelve weeks, as well their standard medical treatments, from June 2023 to March 2024. Evaluation included symptom severity, hand grip strength, and upper extremity lymphedema, assessed using the Symptom Severity Scale, a manual hand-held dynamometer, and tape measurement, respectively. Statistical analysis with significance level 0.05 level.

Results: Unsignificant differences revealed at baseline analysis. Both groups had revealed a significant decrease in symptoms` severity, and upper extremity circumference reported values, and a significant increase in hand grip strength reported values post treatment. While there were significant improvements in group A compared with group B post treatment in terms of symptoms` severity, hand grip strength, and upper extremity circumference ($p<0.001$).

Conclusion: It could be concluded that adding neural mobilization to physiotherapy rehabilitation program improves symptoms` severity, hand grip strength, as well upper extremity circumference in in women with carpal tunnel syndrome secondary to post-mastectomy lymphedema.

Keywords: Neural Mobilization, Carpal tunnel syndrome, Lymphedema, Post mastectomy, Symptom severity Scale, grip strength, Hand held-dynamometer

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INTRODUCTION

Upper extremity lymphedema was addressed as a chronic debilitating lesion that takes place in around 20 % of females post cancer breast management involving resection of lymph nodes within axillary, also post biopsy usual of sentinel nodes by 6-8% [1]. Almost, lymphedema was classified as a chronic lesion regarding lymphatic system either valvular dysfunctioning, or vascular ectasia those resulted in interstitial storage of lymphatics contents` reflux [2]. Clinical trials regarding CTS addressing developed lymphedema risk factor is well-respected, others ensure that lymphedema is the potential issue that results in development of CTS [3, 4].

Carpal tunnel syndrome (CTS) refers to a collection of hand symptoms resulting from compression of the median nerve at the wrist. It is physiologically characterized by increased pressure within the carpal tunnel and impaired nerve function at that site [5].

Painful clinical manifestation involving numbness, plus regressed motor functioning almost recorded among CTS

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as a popular neuropathy lesion even among lymphedema women who have breast cancer [6].

Popular association of carpal tunnel lesion with lymphedema as a well-known syndrome almost assigned with splinting, or adding steroids, even surgical recommendation based on its severity [6].

Aggravated de-positioning of fibroadipose resulted in additional pressure within upper limb`s lymphedema always due to repetitive compressing garment therapeutic approach thus fortunately addressed as developing issue for carpal tunnel syndrome (CTS), mainly among advanced lymphedema individuals [7].

Successful CTS management incidences had direct correlation to its severity. Numerous therapeutic interventions regarding CTS i.e., wrist splinting, steroids, as well various physical therapy modalities for advanced individuals might require surgical median nerve decompressing intervention. Recorded failure of conservative management was 7-75% range in case of involving recurrence, and persistent neurophysiological features, even suspected CTS complications [8].

Numerous clinical trials stated that neural mobilization therapy (NM) has extended therapeutic benefits in term of pain management that looks like similar lesions e.g., plantar fasciitis and tendo Achilles tendinopathy [9, 10]. NM is a therapeutic intervention designed for restoring underlying homeostatic status within neural system via mobilizing targeted structure and correlated structures [11].

Popularly recommended physiotherapy management is almost engaged based on carpal mobilizing techniques, ultrasound therapy, and neural glide approaches [12, 13]. So, this study was done to evaluate therapeutic value of neural mobilization in managing symptoms of carpal tunnel syndrome individuals with lymphedema post mastectomy.

MATERIAL AND METHODS

This prospective, Pre/Post-treatment, randomized controlled study was conducted from June 2023 to March 2024 at the Outpatient Clinics of Shebin El Kom Teaching Hospital, Menofyia, Egypt. This study was ethically approved by the Institutional Review Board, Faculty of Physical Therapy, Cairo University (approval No: P.T.REC/012/003933). This study protocol complied with the Helsinki Declaration, the ethical norm of the World Medical Association for human testing. Each participant received a detailed explanation of all procedures of study program of treatment and measurement devices after explaining the research goals and her ability to withdraw at any moment. participants provided their informed consent before enrolment.

Subjects: Forty female participants with carpal tunnel syndrome secondary to post mastectomy Grade III lymphedema were enrolled based on specific inclusion criteria: Their age ranged from 40 to 60 years; had unilateral or bilateral postmastectomy Lymphedema; their carpal tunnel syndrome symptoms persisted for at least 3 months; their clinical manifestations involve; a) parathesias and painful swelling with weakness of the affected hand, exacerbated while sleeping or by repetitive use of the wrist, which would be relieved by shaking the hand with postural change, b) sensory loss with numbness in hand region innervated by median nerve, c) positive Tinel`s sign.

Exclusion criteria:

Patients with local infections at hand level, having a systemic inflammatory disease, cardiac diseases, or other disorders that lead to significant swelling, any disease that could cause polyneuropathy such as diabetes mellitus, local recurrent or distant metastases, cellulites, medication that influences body fluid and electrolyte balance, other causes of carpal tunnel syndrome rather than postmastectomy lymphedema, a cognitive disorder, or receiving psychotherapy, those who have undergone surgery due to carpal tunnel syndrome. Additionally, participants with a pacemaker, any disease affecting the central nervous system, Furthermore, those with arterial or venous circulation disorders or pregnant were excluded from the study. Sample size estimation:

G* Power statistical software (version 3.1.9.2; Universitat Kiel, Germany) was used to determine the optimal size of the sample to collect. Sample size calculation was done using symptom severity scale as a primary outcome with two tailed statistical analysis, actual power $(1-\beta) = 0.95$, $\alpha = 0.05$, and large effect size = 0.1.61. The effect size was calculated using mean and SD of a previous similar study (had same measuring and treating tools) of Oskouei et al. [14], and Munoz-Alcaraz et al. [14]. Calculation of the sample size determined 19 participants per group that increased by 5% to be 20 participants for each group to overcome expected dropout.

The patient`s demographic data included age, height, weight; BMI, medical history, and affected side were collected and recorded on a data sheet.

Randomization: The subjects included were divided randomly into two groups equal in number (n = 20).

Individual and sequentially and unbiased research assistants gave each numbered index cards were placed in opaque envelopes. A blinded and unbiased research assistant gave each participant a hand-picked envelope, which was opened, and the participants were assigned to their group accordingly. Group (A) included twenty female participants who had been treated with neural mobilization, plus routine complex decongestive therapy (Manual lymph drainage, compression bandaging, exercise, skin care) in addition to intermittent pneumatic compression as part of a congestive drainage treatment protocol for lymphedema, also they were received strengthening and stretching exercises for wrist muscles and ligaments, two sessions per week for twelve weeks, as well their standard medical treatments [15, 16]. Group (B) included twenty female participants who had been treated with routine complex decongestive therapy (Manual lymph drainage, compression bandaging, exercise, skin care) in addition to intermittent pneumatic compression as part of a congestive drainage treatment protocol for lymphedema, also they received strengthening and stretching exercises for wrist muscles and ligaments, two sessions per week for twelve weeks, as well their standard medical treatments [16, 17].

After randomization, there was no dropout among the participants (Figure 1).

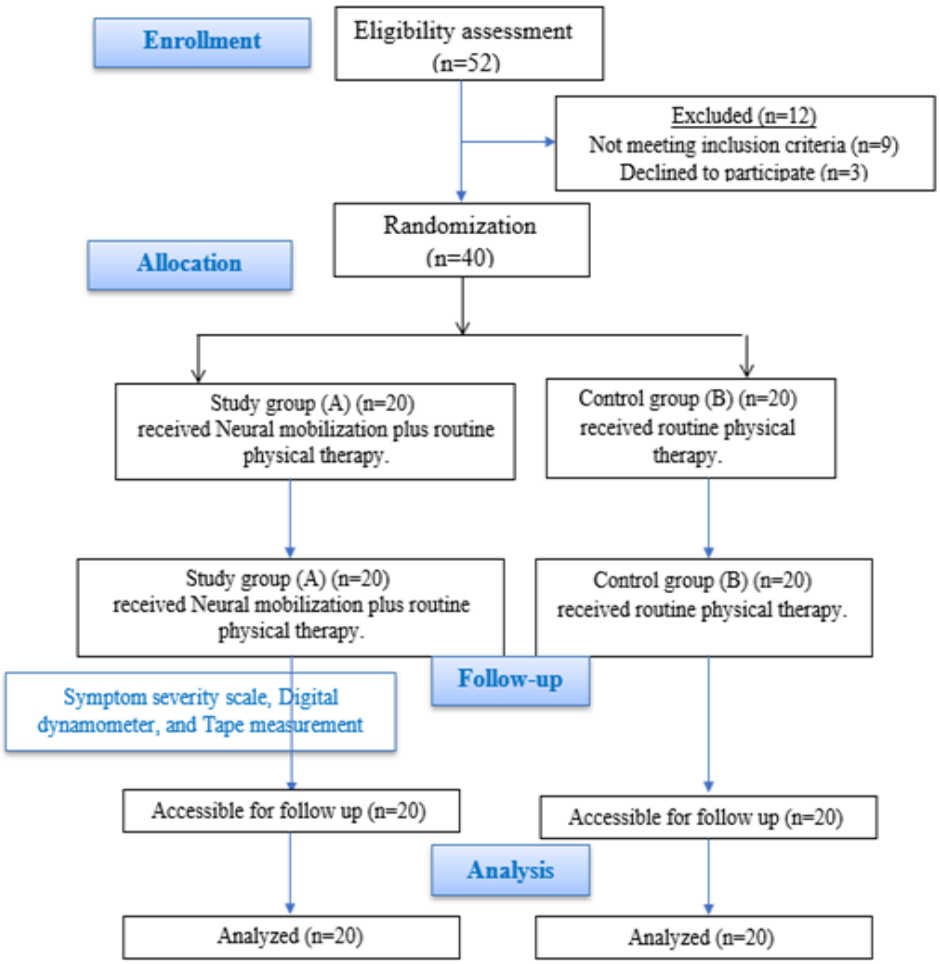

Fig. (1): Flow chart of the study.

Outcome measures: Bottom of Form

Assessments were made before starting the treatment as the first record and at the end of treatment after twelve weeks as a second record.

Body mass index (BMI):

The body weight and height of each woman in both groups (A and B) had been conducted using a a calibrated universal scale of weight and height before beginning of the study, to calculate the BMI in according with the following equation: BMI = weight/ height (kg/m2) [18].

Symptom severity level:

The symptom severity level was assessed for all participants in both groups (A and B) before and after treatment using Arabic version of symptom severity Scale (SSS). Each participant was asked to answer the patient-based SSS of 11 questions on a Likert scale of 1-5 scale that related to participants` symptom severity level [19, 20].

Hand grip strength (HGS):

The HGS was assessed for all participants in both groups (A and B) before and after treatment using the manual hand-held dynamometer (A Riester, Germany-0124). It is a relatively smart, in-expensive, fast, and non-invasive measure for hand grip isometric strength. Each patient was seated in a comfortable chair with a fixed arm rest, where patients` arms at right angles, and their wrists just over the end of the chair's arm, thumb facing upwards. Ensured the dynamometer was reset and instructed to squeeze as hard as possible, by prompting "Squeeze, harder, harder.....stop squeezing". After that, relax for 60 seconds. The measurements were taken three times, and the average was calculated. All repeated measurements were measured from the same position. Noted that hand-held dynamometer reported in Kg [21].

Upper extremity circumference:

A fixable tape measurement was used to measure circumference of upper extremity to evaluate post mastectomy lymphedema (Grade III lymphedema) that was applied at the baseline, and after treatment protocol at mid-arm and mid-forearm. Each patient is seated with own feet flat on the floor and arms at right angles, with an elbow beside the body. Patient`s head looking forward, then three measures taken, and recorded the average from the same

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position. It is popular due to its low cost, pervasiveness, uniformity, and ease of use [22].

Treatment Procedures:

Prior to initiating the exercise program, all participants received education on post-mastectomy lymphedema and were instructed on a home-based exercise regimen. All women in both groups (A and B) underwent:

A comprehensive decongestive physical therapy program aimed at reducing edema. This program included

Manual lymphatic drainage Patients received 20 min of manual lymphatic drainage. The MLD consisted of four basic techniques (stationary circle, rotary technique, pump technique, scoop technique) initiated from unaffected quadrants of the trunk (the neck, chest, abdomen) and after preparation of these regions, the affected areas of the trunk were treated Finally, MLD was applied to the edematous limb starting proximally at the shoulder, moving in segments progressively down the limb. The techniques were performed with higher pressure and slower maneuvers than used in less advanced edema. During MLD, deep diaphragmatic breathing was performed [23].

Therapeutic exercises such as hand pumping exercises and range of motion exercises; each participant received full explanation then asked to relax in supine position, where the researcher applied whole upper extremity ROM exercise for shoulder, elbow, wrist, and each digit [16, 17].

Compression Bandaging was applied as three short-stretch bandages 6, 10, and 12cm in width were sequentially placed around the limb with the first starting at the hand, the second at the wrist, and the third starting below the elbow. Gradient pressure was achieved by applying more layers distally, gradually reducing the number as well as overlap of bandages applied proximally along the arm. Bandages were removed the next day of scheduled treatment Exercises and removed after 24 hours [23].

Skin and nail care, all patients are advised to avoid steam rooms, saunas, very hot baths or showers, wearing clothing (tight clothing and toning jewelry), Look for changes or cracks in the skin, keep it soft by moisturizing daily, keep fingernails short and raise the affected limb above the heart [23].

in addition to intermittent pneumatic compression as part of a congestive drainage treatment protocol; using CRG-2020, Chirag, intermittent pneumatic compression device (India, 18 Watts, a popular 200 mmHg pressure range, device, 110-20 voltage input, with 60Hz frequency, in addition to arm, waist, and leg cuffs). A brief simple explanation given to patient, who sat in sitting well-supported position, then applied suitable arm cuff, and ensured safety, and therapeutic parameters of 60Hz along 30 minutes, two sessions/ week for 12 weeks [15, 16].

Stretch exercise training; each participant received full explanation then asked to relax in supine or sitting position, where the researcher applied whole upper extremity stretching exercise for shoulder, elbow, wrist, and each digit [16, 17].

Strengthening exercise training; each participant received full explanation then asked to relax in supine or sitting position, where the researcher applied whole upper extremity strengthening exercise for shoulder, elbow, wrist, and each digit [16, 17].

Neural mobilization technique: For (Group A) Treatment via neural mobilization was carried out to each patient in group (A), for 30 minutes/ session, 3-sessions/ week for a duration of 12 weeks. Each woman in group (A) was instructed briefly and clearly about neural mobilization and its effect in order to gain their confidence and cooperation through the treatment procedures. Each woman in group (A) was asked to relax in supine position on bed with loose cloths. The researcher was seated at the right side of the bed near targeted upper arm of the participant. Neural mobilization techniques are conducted in the following steps.

Initial stage: each participant was supine, with targeted side shoulder placed in depression, 90° abduction, and external rotation. The researcher has instructed the patient to flex her elbow 90°. Then, the researcher depressed participant`s shoulder girdle. -Noted that patients were positioned so that there was no tension on the median nerve, i.e., head and neck placed in a neutral position and the affected arms positioned at the subjects' side [15, 16].

Main stage: the researcher maintained previous position, plus put patient`s forearm in pronation, then performed passive elbow flexion from 90°. Then, the researcher continued from 90° flexed patient`s elbow, the researcher performed shoulder depression from 90° up to 120° of abduction. Noted that as the intervention progressed, the maneuver was applied in a position with increasing tension on the nerve [15, 16].

The neural mobilization maneuver including oscillatory elbow flexion-extension was carried out 3 times in each session, with 15 repetitions of oscillatory elbow flexion-extension each time, 2 days a week. To increase tension on the median nerve, the position of the arm-forearm-wrist-elbow was altered during the neural mobilization maneuver, depending on the patients [15, 16].

Statistical analysis:

The data was collected and analyzed statistically by utilizing the Statistical Package for Social Sciences (SPSS) (IBM SPSS, Chicago, IL, USA) (version 25) for Windows. The Shapiro-Wilk test was used to verify that the data followed a normal distribution. Homogeneity of variances across groups was carried out using Leven`s test. Descriptive statistics, including mean ± SD, were quantified for all variables. Both paired and unpaired t-test mean and standard deviation, and the standard error were calculated for SSS, and grip strength between (Group A & B) at baseline of the study, and after two months by the end of the study. For all statistical tests, a value of p 0.05 was chosen as the level of significance.

RESULTS

Table (1) represents the descriptive statistics for the patients` demographic data for both groups (A and B&). According to the results at baseline, there was no significant difference between all groups mean values of age, weight, height, BMI, and affected side ($p > 0.05$).

Table (1): Descriptive statistics and comparison of age, weight, height, BMI, and affected side between group A&B

Variables	Group A $\overline{X}$ ±SD	Group B $\overline{X}$ ±SD	t-value	p-value	Sig
Age (years)	**48.8±2.31**	**49.5±2.42**	**-0.863**	**0.399**	**NS**
Weight (kg)	**86.18±6.02**	**87.93±4.08**	**-0.805**	**0.431**	**NS**
Height (cm)	**170.6±1.39**	**170.45±1.10**	**0.497**	**0.625**	**NS**
BMI (kg/m²)	**29.56±1.92**	**30.12±1.78**	**-0.724**	**0.478**	**NS**
Affected side n, %					
Right	**17(85%)**	**16 (80%)**	**0.410**	**0.366**	**NS**
Left	**17(85%)**	**16 (80%)**			
BMI: body mass index; X^2: Chi Square; * Data are mean± SD for all demographics except non parametric data; (%), P-Value < 0.05 indicate statistical significance					

Within and between groups` analysis:

As represented in Table 2, the mean values of both groups (A and B) regarding symptoms severity (SSS) significantly decreased posttreatment compared to pretreatment, also hand grip strength (HHD) significantly increased posttreatment compared to pretreatment ($p < 0.001$).

The percentage of SSS mean values decrease in both groups were 4.46%, and 2.68%, respectively. Where the percentage of hand grip strength (HHD) mean values improvement in both groups were 19.93%, and 5.98%, respectively.

As represented in Table 3, the mean values of both groups (A and B) regarding tape circumference scores (mid-arm and mid-forearm) significantly decreased posttreatment compared to pretreatment ($p < 0.001$).

The percentage of tape circumference scores (mid-arm and mid-forearm) mean values decrease in both groups were 1.3%, and 0.5%, in terms of mid-arm, also 4.57%, and 1.57%, in terms of mid-forearm, respectively.

Table (2): SSS and HHD pre and post treatment for both groups

Variables	Group A $\overline{X}$ ±SD	Group B $\overline{X}$ ±SD	t-value	p-value
SSS				
Pretreatment	45.9±1.77	45.65±1.46	0.474	0.641
Posttreatment	23.6±3.378	23.25±1.682	-12.763	0.001
Mean difference	**-2.23± 3.23**	**-1.34± 1.6**		
% of change	**4.46%**	**2.68%**		
t-value	30.878	37.393		
p-value	0.000	0.000		
HHD				
Pretreatment	9.815± 0.24	9.77± 0.25	0.478	0.638
Posttreatment	13.8 ± 3.378	10.91 ±1.682	17.055	0.000
Mean difference	-3.985 ± 0.372	-1.135 ± 0.274		
% of change	**19.93%**	**5.98%**		
t-value	-47.942	-1.007		
p-value	0.000	0.000		
HHD: Hand Held-Dynamometer. **SSS:** Symptom Severity Scale				

Table (3): Tape measures pre and posttreatment for both groups

Tape measures		Group A $\overline{X}$ ±SD	Group B $\overline{X}$ ±SD	t-value	p-value
Pre	**Mid-arm**	36.85± 1.18	37.08± 0.878	-0.92	0.369
	Mid-forearm	28.53± 1.02	28.65± 1.763	-0.253	0.803
Post	**Mid-arm**	36.2± 1.06	36.83±0.832	-2.465	0.023
	Mid-forearm	26.93± 0.977	28.1± 1.796	-2.44	0.025
MD	**Mid-arm**	0.65± 0.709	0.25± 0.256		
	Mid-forearm	1.6± 0.308	0.55± 0.154		
% of change	**Mid-arm**	1.3%	0.5%		
	Mid-forearm	4.57%	1.57%		
t-value	**Mid-arm**	4.1	4.359		
	Mid-forearm	23.247	15.983		
p-value	**Mid-arm**	0.001	0.000		
	Mid-forearm	0.000	0.000		

DISCUSSION

Up to date, there is an actual clinical need for addressing the most proper approach that is efficient, safe manual technique in mild, and moderate CTS, plus growing evidence for efficacy of adding neural mobilization for physical therapy rehabilitation protocol regarding post mastectomy (Grade III lymphedema) individuals. Therefore, current study aimed to evaluate therapeutic

value of neural mobilization in managing symptoms of carpal tunnel syndrome individuals with lymphedema post mastectomy.

The findings of the present study revealed that there was a statistical decrease in the mean values of symptoms severity, and a statistical increase in the mean values of hand grip strength in both groups in favor of group A ($p < 0.001$), where percentage of improvements were 4.46%, and 2.68% for SSS, and 19.93%, and 5.98% for HHD, respectively. In addition, there was a statistical decrease in the mean values of upper extremity circumference (mid-arm, and mid-forearm) in both groups in favor of group A ($p < 0.001$), where percentage of improvements were 1.3%, and 0.5% for mid-arm, and 4.57%, and 1.57% for mid-forearm, respectively.

Chronic CTS has significant individual and socioeconomic impacts, particularly in post-mastectomy women with Grade III lymphedema. The increased carpal tunnel volume compresses the median nerve, leading to sensory loss in the median dermatome and reduced grip strength. These findings highlight the need for a comprehensive neuro-rehabilitation approach that considers the unique clinical presentation of both CTS and advanced lymphedema in this population [24].

Simultaneous improvements in function and symptom relief were observed in both groups, which may be attributed to the enhancing effects of manual lymphatic drainage. This technique likely stimulates not only subcutaneous lymph capillaries but also circulation within deep lymphatic collectors. These deep collectors facilitate the removal of edema, alleviating both intraneural and extra neural tension, which may improve median nerve mobility, leading to symptom alleviation as nerve swelling diminishes [25].

An alternative pathophysiological explanation for carpal tunnel syndrome involves a reduction in the median nerve's ability to glide along its longitudinal axis. This restriction is attributed to abnormal tension exerted on the nerve during upper limb movements, which may lead to fibrosis within the intraneural connective tissue. Neuro-mobilization techniques are designed to address this dysfunction by modulating tension within the nerve and its surrounding connective tissue, thereby contributing to symptom relief [25].

It also reduced the median nerve's cross-sectional area, possibly by enhancing nerve mobility, reducing adhesions, improving axoplasmic flow, and promoting cortical reorganization plus accompanied improvement of carpal tunnel structures enhances possibility of selective proprioceptive improvements, relieve pain complaints through feedback on large-diameter afferent nerve fibers and cause a reduction in the excitability of small-diameter nerve fibers, also stimulates mechanoreceptors through fixing soft and articular structures of wrist that in turn modulates pain intensity[26] .

The present clinical study came in line with an earlier clinical trial conducted by Oskouel et al. [15] had stated that neural mobilization permits correction on CTS patho-physiolocal alteration through minimizing neural adhesive within CT around median nerve, even resolve surrounding fibrosis at intraneural connective structures. That might explain the role of neural mobilization in restoring the normal physiological neural structure longitudinal gliding within CT, which reduces surrounding inflammatory nutrients, and swelling. They examined a total of 32 hands of 20 CTS individuals; their mean age was 46.7 ± 11 years with duration of clinical manifestations 19.6 ± 15.9 months. They reported an improvement in SSS by 37% among those who received neural mobilization, plus their routine physical therapy protocol. While control groups received routine protocol of transcutaneous electrical nerve stimulation, ultrasound therapy, and night splinting in neutral position improved by 23%.

In the same line with the present study findings, Mohamed et al. [27] who conducted a clinical randomized trial on 28 patients suffering from chronic CTS (4-16 months), their age 34.05 ± 10.19 years. They stated that median neural mobilization reported satisfactory improvement in term of clinical manifestations (63.7 ± 0.5 pretreatment, and 51.6 ± 0.4 post treatment), over conventional physical therapy protocol (63.3 ± 0.5 pretreatment, and 62.1 ± 0.5 post treatment), for mild to moderate CTS individuals that delay or prevent CTS progression, also subsequent surgical interventions.

Ballestero-Perez et al. [28] also conducted a metanalysis concerning median neural gliding approach on CTS`. Ballestero-Perez and his team had addressed thirteen clinical trials, and clinical and physical, also electrophysiological diagnosis for CTS. Finally, they ensured an improved all clinical features, and functional capabilities in CTS. Furthermore, study group had received median neural gliding, plus the conservative therapy exhibited additional functional improvement in term of grip strength, particularly in affected CTS` grip ($P < .05$).

In addition, Bartkowiak et al. [29] had stated that gained improvements of neural gliding in combined with low-level laser and/ or ultrasound therapy double week's therapy in mild to moderate CTS` manifestations such as sensory impairments, and grip strength, even functional Boston Questionnaire findings.

In agreement with current study findings, some evidence has stated that neural mobilization as therapeutic approaches has been applied as a sort of manual therapeutic intervention that has obvious benefits which receive much attention from academic researchers. They conducted their experimental trial on 100 postmastectomy women suffering from sensory-motor impairments, their age range was 30-65 years old. Flexible tape measures were utilized for evaluating upper extremity lymphedema severity. It provides clinical improvement based on that neural tissues' mobilization permits valuable improvements that could permits suffers remarkable improvements in terms of symptoms severity mainly among those who have mild and moderate lymphedema in favor to who had severe lymphedema [24].

Additionally, in a study by Ibrahim et al. [30] who stated that breast cancer women treating with chemotherapy can be treated with sensorimotor training to reduce their symptoms and improve their balance and function. Another study by Abdelrauf et al. [31] reported that in treatment of

lymphedema compression bandaging could be used alone effectively there by reducing the cost and time of complete decongestive therapy. A study by [32] who claimed that the usage of Multilayer bandages (Mobiderm bandage) produces objective improvement in lymphedema more than the usage of Intermittent Pneumatic Compression.

The study findings also agree with those of Nadkarni and Jagtap [33] who had conducted a clinical trial to visualize the best treatment approach for managing post mastectomy lymphedema. They conducted their clinical trial on 33 participants who undergone a modified radical mastectomy of Krishna Vishwa Vidyapeeth institution. Their outcome measures included circumferential measurement using flexible, non-stretch measuring tape, shoulder mobility using universal goniometer. The treatment protocol involved neural mobilization, and manual lymphatic drainage. They had stated that the combination of neural mobilization, and lymphatic drainage provides notable benefits in whole upper extremity circumference, and functional capability.

Strengths and Limitations:

This study demonstrates the value of neural mobilization, which was found to be effective while lacking adverse effects. It also supports their integration as a crucial part of rehabilitation for patients with carpal tunnel syndrome secondary to post-mastectomy Grade III lymphedema. Also, additional strengthening points of this research include the randomized design, the objective evaluative measures, and the valuable therapeutic approaches offered by skilled physiotherapists.

Nevertheless, this study had certain limitations, such as the fact that patients` psychological and physical health may have affected the evaluation and treatment results, and the fact that environmental conditions might have affected the patients` response. Also, larger sample sizes were needed. Furthermore, this study was conducted without following up upcoming patients` response to treatment procedures. So, further studies are needed to investigate the short- and long-term effectiveness of adding neural mobilization to physiotherapy rehabilitation program on pain severity, improves wrist range of motion and improves hand grip strength, as well hand skill in chronic carpal tunnel syndrome, mainly among post mastectomy (Grade III lymphedema) women.

CONCLUSION

It could be concluded that adding neural mobilization to physiotherapy rehabilitation program improves symptoms` severity, improves hand grip strength, as well upper extremity circumference in carpal tunnel syndrome women with lymphedema post mastectomy.

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Conflict of interest:

The authors don`t have any conflict of interest to declare.

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